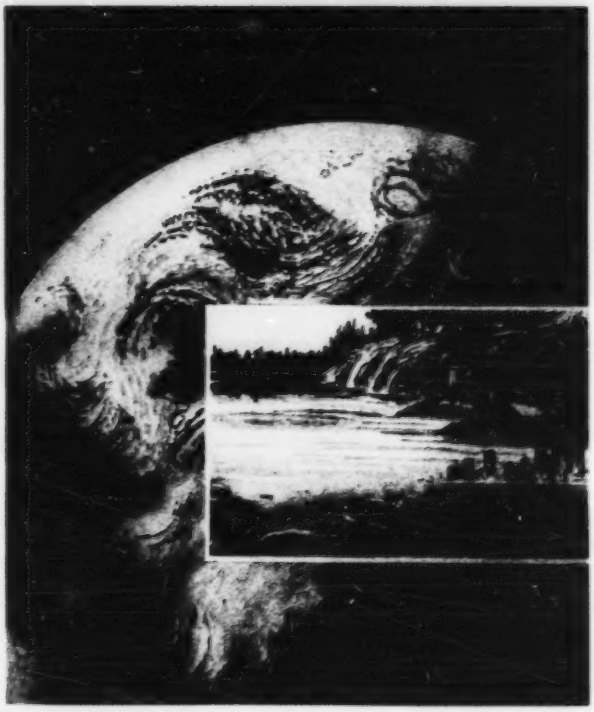
# Wastewater Technology Centre



1990
Program
Overview

Technology
Development
Branch

Environment Canada
Environnement Canada

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# Wastewater Technology Centre

## 1990 Program Overview

Wastewater Technology Centre
Technology Development Branch
Conservation and Protection
Environment Canada

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# Introduction

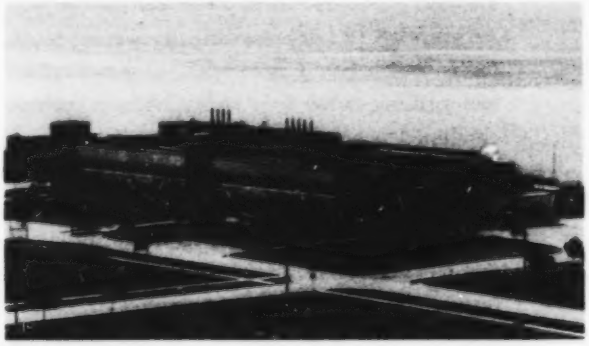
The Wastewater Technology Centre (WTC) is one of six national research institutes within the Conservation and Protection Service of Environment Canada. The WTC and its associated facility, the River Road Environmental Technology Centre in Ottawa, are part of the Technology Development Branch. The WTC undertakes research and development of environmental protection technology in areas related to water pollution control and waste management. It also serves in an advisory capacity to various levels of government with regard to the technological basis for regulatory control of contaminants emanating from wastewaters and their associated residues.

The WTC is the foremost facility for water pollution control research in Canada and provides the focal point for water pollution control technology in Canada's international trade negotiations.

# Inside the WTC

The WTC consists of three research and three support divisions:

- Biological Processes
- Physical/Chemical Processes
- Residue Management
- Laboratory Services
- Computing and Informatics
- Support Services



The Wastewater Technology Centre (WTC) is located in Burlington, Ontario

Scientists, engineers and various support staff in these divisions share a unique research facility consisting of a wide variety of wastewater and sludge treatment pilot plants, laboratories, and offices. Emphasis is placed on developing bench scale and pilot scale processes utilizing industrial wastewaters, municipal and industrial sludges and other contaminated materials. Mobile pilot scale process units and laboratories are employed to facilitate field projects and demonstrations at locations across Canada.

In developing technologies, emphasis is placed on improving both the environmental and economic performances of treatment facilities. This involves the development of innovative process technologies designed to minimize waste generation and to optimize the treatment capability for industrial and municipal waste streams. Outstanding examples of process technologies that have proven to be highly cost-efficient and environmentally effective include the application of anaerobic processes to pretreat high-strength industrial wastewater, the low temperature conversion of municipal sludge to fuel oil, and the quantification and modelling of the natural degradation process for the treatment of gold mining effluents.

In the area of innovative technology demonstration, the WTC has been actively involved in the development of Canada's first full-scale demonstration of the Oil-From-Sludge technology at the Highland Creek Sewage Treatment Plant in Toronto. The final negotiations for this $20 million project have just been concluded and the system is expected to be fully operational by 1992. The incorporation of the Oil-from-Sludge technology at Highland Creek will enable the operators of the sewage treatment plant to increase its wastewater treatment capacity while taking full advantage of the resource potential of the associated sludge.

In the area of pollution control and system optimization, the WTC is involved in the implementation of strategies and control systems to optimize the planning and operation of wastewater collection and treatment facilities. Specifically, the Centre is involved in a number of Remedial Action Plan (RAP) areas throughout the Great Lakes Basin where a need has been identified for better strategies and new technologies to manage combined sewer overflows and stormwater discharges. To address such problems, the WTC is establishing a control technology evaluation and demonstration program. Specific technologies that will be demonstrated include real-time monitoring and control to optimize system storage and treatment capacity, as well as high rate treatment devices involving physical separation and disinfection.

A specific flow control optimization strategy that has been successfully demonstrated at the plant level is "step feed" control. This project, undertaken at the Dundas Sewage Treatment Plant, involved some minor physical modifications to the plant and the introduction of a computer assisted control procedure. Step-feed control is expected to bear effective strategy for reducing stormflow bypass at other sewage treatment plants throughout the Great Lakes Basin.

Technology transfer is an important activity of the WTC in ensuring that improved technologies and processes are made available and marketed to users. It also provides a means by which knowledge can be shared and research needs are identified. The WTC played a central role at the international conference and trade show, Globe 90, towards ensuring full participation by the Canadian environmental companies involved in the development of innovative new technologies. Other technology transfer activities include the publication of scientific and technical information, organization of and participation in seminars and workshops, support to professional organizations and regular communication with the scientific and industrial communities in Canada and abroad.

## Partnerships

The WTC works closely with industry, all levels of government, academia, professional organizations and international agencies. These associations represent an essential ingredient to the success of the WTC in developing solutions to environmental problems.

The WTC recognizes the importance of close collaboration with industry to ensure that the best investments are made in support of environmental research. This direct involvement with industry gives researchers at the WTC a valuable perspective on the problems associated with operating treatment facilities in the most cost-efficient manner. It also increases the probability that any new or modified technology or process that might be proposed or developed will be implemented.

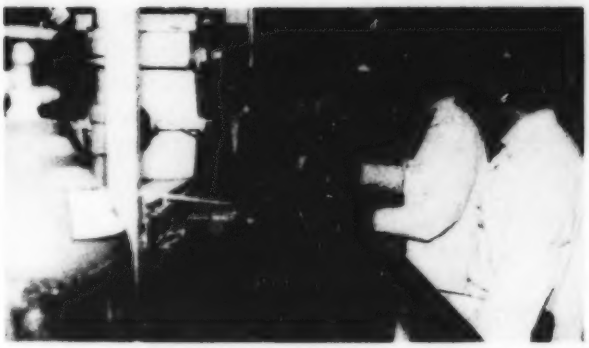
In the pulp and paper sector, the WTC has initiated a technology development and demonstration program directed towards the removal of

chlorinated organic contaminants from pulp and paper mill effluents, particularly those from bleached kraft mills. The program focuses on two critical areas. Firstly, the development and demonstration of optimized treatment plant designs that can be implemented relatively inexpensively by all bleached kraft mills in existing secondary treatment facilities; and secondly, the development of membrane and advanced bioreactor technology for application to high strength segregated bleach plant effluents. Laboratory scale technical feasibility studies are underway for both of these chlorinated organics removal initiatives. Preliminary discussions have taken place with candidate mills for pilot-scale demonstration of the technologies in 1992 and 1993. Full-scale demonstration could occur as early as 1994.

In the iron and steel sector, the overall objective of the "clean up" program is to develop strategies and technical solutions to improve effluent quality. While this sector has made significant advances in the wastewater treatment, additional performance assessment and technology development work is required for the implementation of pre-treatment options to optimize contaminant removal. Both bench scale testing and pilot plant construction were initiated in 1990 and a mill has been selected for the demonstration of this project.

The automobile parts manufacturing sector represents a major challenge given the diversity of the industry and its importance in the Great Lakes Basin. It is anticipated that the Automotive Parts Manufacturing Association (APMA) and its member industries will serve as a major focus of the WTC's pollution prevention activity. Negotiations with the APMA have proceeded rapidly and a team has been established to undertake the effluent characterization and treatability studies required to identify suitable sites for implementation of pollution prevention technology.

Within the municipal sector, the WTC continues to be involved in the development of techniques to improve the effectiveness of toxic substances



**The WTC provides the focal point for water pollution control technology in Canada's international trade negotiations**

control and toxicity removal at sewage treatment plants. Initially, this work involves the development of a predictive model to determine the fate of toxic substances within the sewage treatment process. The development and calibration of the model will lead to full-scale demonstration of its effectiveness in toxics removal at an Ontario sewage treatment plant within the Great Lakes Basin during 1993-94. The first version of the predictive model will be available in April, 1991.

The WTC has initiated preliminary discussions with industry representatives to identify candidate sites for the demonstration of pollution prevention technology in other sectors. In the organic chemicals sector, for example, a proposal is being developed to evaluate a granular, activated carbon-assisted anaerobic reactor system which will be used as a biological pretreatment system for specific inhibitory organic chemical plant waste streams. A potential industrial partner has been identified for the demonstration of this system.

The WTC relies on Canadian universities as a source of research and expertise. As an example of its commitment to strengthening this relationship, the WTC co-sponsors (with Imperial Oil Ltd.) the Chair in Environmental Systems Engineering, at McMaster University in Hamilton, Ontario. Over the next two years, the WTC will continue its efforts to promote university chairs for other environmental concerns.

The international community is an important source of expertise and offers potential for Canada to expand its marketing capabilities. The WTC has maintained liaison with several international professional associations, government agencies and committees. These include the United States Environmental Protection Agency, the European Economic Community, technical organizations in several European and Scandinavian countries, the NATO Committee on Challenges to Modern Society, the International Association for Water Pollution Research and Control and the Water Pollution Control Federation. Specifically, the WTC has played a central role in bilateral discussions with Germany and France to establish joint research programs in the areas of wastewater treatment, waste management and site remediation.

## Future Challenges

Environmental protection is a high priority at all levels of government in Canada. In promoting the concept of sustainable development - the integration of economy and environment to ensure the quality of the resource base for future generations - federal and provincial government agencies will continue to depend on improvements and optimization of water pollution control and residue management technology.

The WTC has the expertise and facilities to provide research and technological development to support a wide range of government programs and priorities. These include Halifax Harbour, the St. Lawrence Action Plan, the Great Lakes Remedial Action Plans, Ontario's Municipal-Industrial Strategy for Abatement Program, western Canadian quality concerns and the Fraser River.

Biotechnology, information systems and advanced industrial materials, collectively referred to as the "enabling technologies", are currently the focus of policy and research initiatives in many industrialized countries. These areas are also fundamental to wastewater treatment, groundwater treatment, and residue management. For example, biotechnology is the focus of much of the research and technology development undertaken at the Wastewater Technology Centre. Expert systems development for the selection of treatment methodologies and in-plant process optimization is another important component; such systems offer tremendous potential for maximizing cost-efficiency while maintaining environmental quality control. The area of advanced industrial materials development is also important for waste control and treatment; potential applications include landfill liners, waste stabilization and new types of membranes and coagulants for physical/chemical wastewater treatment.

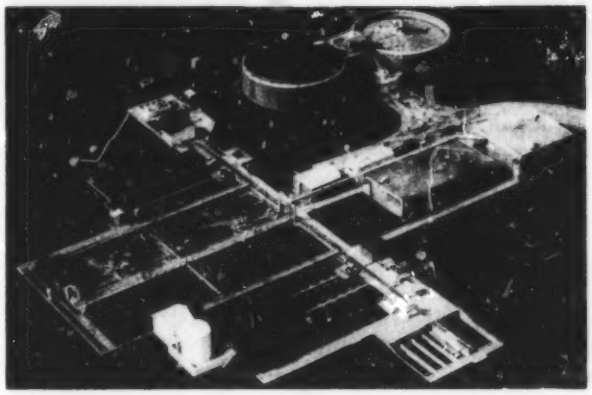
In addition to developing state-of-the-art water pollution control technologies, the WTC may soon begin a test run as a government-owned, contractor-operated (GOCO) facility. This arrangement would enable the Centre to bring its research and development to the marketplace while allowing its laboratory staff to share in the profits of successful technological innovations.

# Biological Processes Division

The Biological Processes Division evaluates, develops, and demonstrates biotechnology for municipal and industrial wastewater treatment. Raw effluents containing excessive levels of biodegradable organic pollutants, or nutrients such as nitrogen or phosphorus, can be treated most economically by utilizing the natural biocatalytic properties of aerobic or anaerobic micro-organisms.

The Division comprises scientists and engineers who combine a knowledge of microbiology and biochemistry with the principles of biochemical process engineering and statistical analysis to develop practical approaches to wastewater treatment problems. Bench scale, pilot scale and full scale projects, using both fixed-film and suspended growth biological processes, are frequently undertaken to facilitate the development and application of innovative biotechnologies that have the potential for both environmental and economic success.

The major programs currently managed by the Biological Processes Division include:



Successful demonstration of automated sensor-based computer control at Tillsonburg Wastewater Treatment Plant

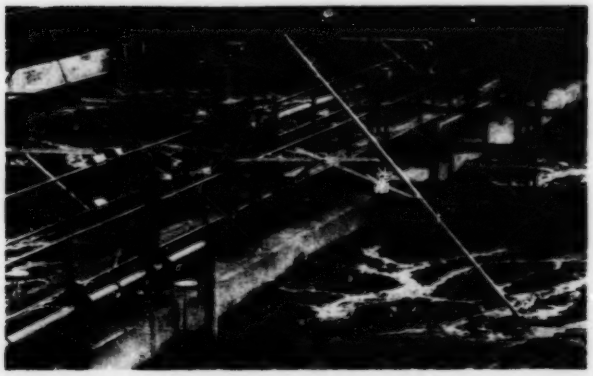
- Computer Control of Biological Treatment Processes
- Trace Contaminant Control
- Pulp and Paper Wastewater Treatment
- Compliance Monitoring Methodology
- Development of Advanced Biotreatment Technologies

## Computer Control of Biological Treatment Processes

Biological processes are widely used for municipal and industrial wastewater treatment in Canada. Often the treatment capacities of these systems may be under-utilized, or the operating costs and energy consumption rates may be higher than necessary. Their performance may also be limited by a lack of adequately trained operating staff. The treatment capacity of Canada's existing biological wastewater treatment infrastructure could be extended considerably through the application of advanced automation techniques and expert systems as operational tools.

The objectives of this program include the development and demonstration of computer-based process audit techniques for assessing the true capacity of an existing wastewater treatment plant and for determining the potential energy savings and other benefits achievable with automated process control. By eliminating process operational bottlenecks and by introducing automation to optimize plant capacity, capital intensive plant expansions may be deferred or cancelled.

Another objective is the development of knowledge-based expert systems for biological treatment processes. When properly designed and verified, expert systems could offer advice to plant operators and provide the potential for rapidly solving operational problems that cannot be resolved using conventional methods.



**Dissolved oxygen control shows up to 30% savings in treatment plant aeration power costs**

## Recent Activities and Accomplishments

- The demonstration of computer-based control at the Tillsonburg, Ontario Water Pollution Control Plant (WPCP).
- Technical direction was provided to process audits for optimizing biological wastewater treatment facilities in support of the Hamilton Harbour Remedial Action Plan initiatives.
- The WTC supported work at McMaster University to further develop and demonstrate a dynamic model-based General Purpose Simulator (GPS) as a tool for optimizing sewage treatment plant operation.
- The WTC began operating the Town of Banff's WPCP under contract as part of a five-year operational plan to demonstrate the successful incorporation of state-of-the-art treatment processes and advanced control technologies. WTC has since subcontracted Aquatrol Technologies Ltd., a fully owned subsidiary of Reid Crowther and Partners Ltd. (design consultant for the plant) to provide day-to-day operation of the facility.

## Future Challenges

- Determine optimum control strategies for the individual solids and sludge handling unit processes, and integrate them with effective liquid train control strategies to demonstrate overall optimization of the activated sludge treatment process at the Banff WPCP.
- Evaluate the cost-effectiveness of contract operation of water pollution control plants through the activities of the Banff demonstration.
- Expand the process audit methodology to include the sludge processing train and industrial sewage treatment applications in order to utilize this technology in the timely and effective resolution of Environment Canada priorities, such as the Great Lakes Clean Up initiatives.
- Facilitate the further development of the General Purpose Simulator, and its progressive transfer to a user-friendly, PC-based workstation format.
- Develop and demonstrate automated process control algorithms for high rate anaerobic treatment processes applied to toxic and inhibitory industrial wastewaters.
- Continue the demonstration of the automated process control system at the Tillsonburg Water Pollution Control Plant.
- Calibrate and apply computer models to optimize the biological treatment of organic chemical wastes in support of the Great Lakes Program.

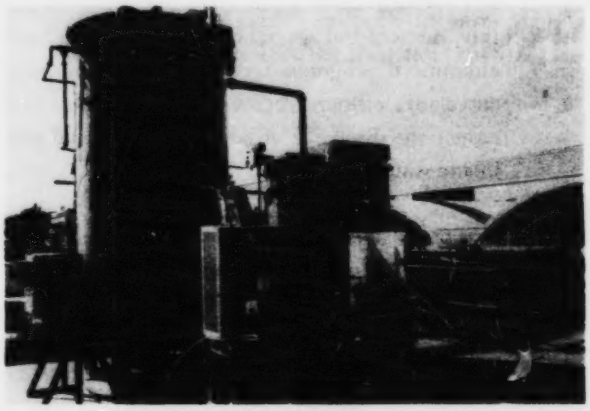
## Trace Contaminant Control

Municipal wastewater treatment plants receive toxic pollutants from many domestic and industrial sources. Although pretreatment can effectively control industrial contaminants, it cannot be easily applied to commercial and household sources. An understanding of the fate of these contaminants during wastewater treatment and their effect on treatment processes can assist municipalities to define sewer use control programs to ensure that plant operation and treated effluent discharge requirements are not compromised.

Improvements in the control of toxic contaminants would be facilitated by models that would predict the fate of contaminants during municipal wastewater treatment. Biological Processes Division staff are working to incorporate pilot and full scale process data into a computer-based modelling system which simulates the behaviour of contaminants under various operating conditions. The objective of the models is to predict the emission rates of toxic contaminants that occur in treated effluents, waste sludges and process off-gases at municipal water pollution control plants.

### Recent Activities and Accomplishments

- Bench scale studies utilizing radioactive labelling techniques were carried out on a number of specific contaminants including 1.4-dichlorobenzene, trichloroethylene, toluene, and chloroform.
- A user-friendly PC-based model called "TOXCHEM" is under development. It predicts the fate of trace contaminants during the treatment of municipal sewage and industrial wastewaters.
- Parallel bench scale and pilot scale studies were conducted on a range of metals, chlorinated phenolics and pesticides to develop calibration co-efficients for TOXCHEM.



Field research demonstrates the fate of toxic contaminants in sewage treatment plants

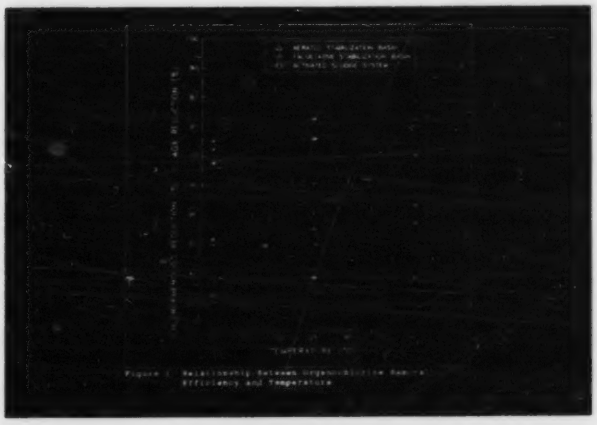
### Future Challenges

- Complete an extensive series of bench and pilot scale experiments to generate physical and biological constants which are not yet available for many of the substances included on priority pollutant lists.
- Produce trace contaminant fate data to describe the behaviour of specific priority pollutants identified for regulation under the Municipal-Industrial Strategy for Abatement Program.
- Verify the applicability of the TOXCHEM model in both sewage treatment plant and industrial Wastewater Treatment Plant applications in support of the Great Lakes Cleanup Program.
- Establish the capability to advise agencies on new methods and tools required for assessing and developing trace contaminant control strategies.

# Pulp and Paper Wastewater Treatment

The pulp and paper industry is one of Canada's largest manufacturing sectors. Recent attention has been focused on conventional and toxic pollutants discharged from pulp and paper mills. Environment Canada, the Ontario Ministry of the Environment and several other jurisdictions have announced programs for revising existing pulp and paper effluent regulations to substantially reduce the discharge of pollutants to coastal and inland waterways.

One of the objectives of the WTC pulp and paper program is to support the revision of effluent regulations for conventional pollutants by re-assessing the performance capabilities of conventional biological treatment processes, such as aerated lagoons and activated sludge systems. The results could be used to define new effluent standards for mills based on the implementation of secondary treatment. A second objective is to develop and demonstrate advanced anaerobic and aerobic biotechnologies for removing toxic compounds, such as chlorinated organic chemicals found in bleached pulp mill effluents or the highly concentrated wood extractives in chemi-thermomechanical pulping (CTMP) wastewaters. Efforts are also being devoted to the incorporation of advanced physical/chemical techniques, such as membrane separation, into biological treatment systems to improve process performance and reliability.



**Relationship between organochlorine removal efficiency and temperature**

## Recent Activities and Accomplishments

- Technical assistance was provided to four full scale anaerobic treatment programs in the Canadian pulp and paper industry.
- The fate and effect of toxic components of high strength CTMP wastewaters on anaerobic and aerobic treatment process microorganisms was assessed.
- Aerobic or anaerobic/aerobic biological treatment systems for BOD removal, toxicity removal, and nutrient control for high strength CTMP wastewaters were demonstrated.
- High rate anaerobic process technology was investigated for anaerobic dechlorination of selected wastewaters from bleached kraft mills.
- A national 1989 data base summarizing dioxins in pulp mill effluents was assembled and reviewed.
- The potential of membrane separation technology was assessed for toxics control of selected wastewater streams from kraft pulp bleach plants.
- After detailed review of the literature and discussion with several North American and European experts, 13 ultra-filtration/microfiltration (UF/MF) membranes were selected as most suitable for pulp mill effluent treatment. These membranes were then characterized and their performances were evaluated.

### Future Challenges

- Develop improved treatment technology and expert systems for the removal of conventional pollutants from pulp and paper wastewaters.
- Test new membrane materials and systems specifically suited for removing toxic organics from pulp and paper effluents.
- Develop process design relationships for optimizing the removal efficiencies for adsorbable organic halogen in conventional biological treatment processes such as activated sludge or aerobic lagoons.
- Develop and demonstrate treatment systems for removal of colour and non-biodegradable organics from pulp and paper wastewaters.
- Provide technical advice on pollution prevention initiatives within the pulp and paper sector.

## Compliance Monitoring Methodology

Biological treatment technologies have been widely adopted for both municipal and industrial wastewater treatment. Acceptable design approaches for these systems have been well defined by many years of process research. Nonetheless, many treatment plants do not perform with the consistency intended by their designers. Better methods of gathering and analyzing information about the process can assist regulators and plant operators to improve the ability of existing facilities to comply with pollution control legislation.

The WTC is working to identify useful approaches for managing and interpreting treatment plant data. The objective of the work is to demonstrate techniques that would enable regulators and plant operators to extract information from data more effectively. In addition, the WTC is a joint sponsor, along with the U.S. Environmental Protection Agency, of the Secondary Clarifier Research Technical Committee. The Committee's mandate is to improve the compliance status of biological treatment plants by developing better information about the design and monitoring of secondary clarifiers, which are critical to final effluent quality.

Computer generated display of effluent monitoring data

### Recent Activities and Accomplishments

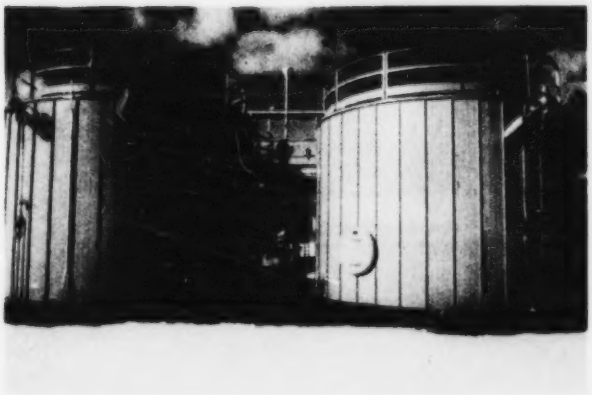
- A report was prepared for Ontario petroleum refineries summarizing results under the province of Ontario's Municipal Industrial Strategy for Abatement (MISA) program. Flow, chemical concentration and toxicity results obtained by the seven Ontario refineries were summarized and analyzed.

- A project was initiated to manage, summarize and analyze MISA monitoring data for the 27 pulp and paper mills in Ontario.
- The Clarifier Research Technical Committee developed plans for evaluating and revising a test protocol for rating secondary clarifier performance.
- The Clarifier Research Technical Committee summarized secondary clarifier design standards from various U.S. States, Canadian provinces, and European and Asian countries to improve secondary clarifier design and monitoring methods.

### Future Challenges

- Prepare a report for Ontario pulp and paper mills to summarize their performance under the Ontario MISA program.
- Provide advice and assistance in the development of a nationwide compliance data handling system in support of Industrial Programs Branch.
- Develop computer software for managing and analyzing pulp and paper effluent data in support of Ontario Region.
- Prepare a report for Ontario mines to summarize their performance under the Ontario MISA Program.
- Conduct a study to determine the main sources of non-compliance at Ontario municipal sewage treatment plants.

## Development of Advanced Biotreatment Technologies



**Autothermophilic aerobic digestion systems aid small communities to minimize sludge disposal costs**

Continued improvements in water quality can be achieved either through the application of conventional wastewater treatment systems, or by the development and demonstration of innovative technologies that show potential for more efficient wastewater management. The objective of this program is to identify or develop new approaches to biological wastewater treatment that show potential for more effective performance or cost-efficient operation.

### Recent Activities and Accomplishments

- The newly constructed autothermal thermophilic aerobic digestion (ATAD) facility at the Banff, Alberta Water Pollution Control Plant successfully commissioned and operated to provide a high quality digested sludge.
- An assessment was made of the potential for bioremediation of contaminated coal gasification sites.
- Under contract to the WTC, Enviromega Ltd. of Campbellville, Ontario, demonstrated the use of step feed operating techniques at the Dundas Wastewater Treatment Plant to minimize bypassing of untreated wastewater during storm events.
- Under joint direction of the WTC and the Ontario Ministry of the Environment, a

study was conducted to evaluate the costs and feasibility of retrofitting selected Ontario plants for step feed operation.

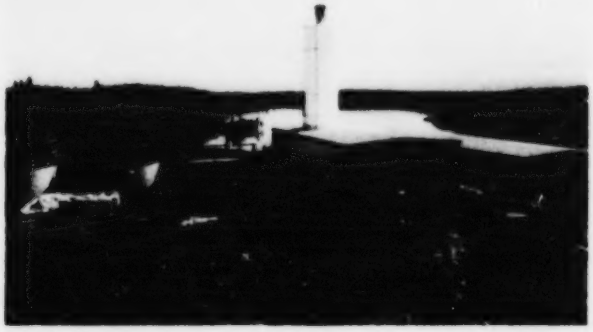
## Future Challenges

- Apply improved high rate anaerobic reactor designs to the treatment of noxious industrial wastewaters.
- Investigate the extent to which autothermal thermophilic aerobic digestion sludge treatment can produce a stabilized and pasteurized sludge suitable for land disposal.
- Develop and demonstrate fixed-film biological treatment systems for dilute waste streams and contaminated groundwater.
- Develop and demonstrate sequencing batch reactor technology for contaminated groundwater treatment.
- Develop bioremediation techniques for the remediation of contaminated soils.
- Demonstrate the use of step-feed operating techniques to minimize bypassing of untreated wastewater during treatment plant overloading due to excessive stormwater flow at the Woodward Avenue Wastewater Treatment Plant.
- Develop and evaluate a procedure for estimating the capacity of municipal treatment plants under conventional and step feed operation.

# Physical/Chemical Processes Division

The Physical/Chemical Processes Division undertakes research, evaluates methods and develops new technologies for the physical and chemical treatment of wastewaters and contaminated groundwater. The target contaminants or other undesirable constituents of these waters are normally not considered treatable by biological methods or may require physical/chemical treatment in addition to biological treatment.

The pollutants of concern include complex synthetic organic compounds and heavy metals. These substances may be dissolved in the wastewater or associated with suspended particulates. A wide range of physical and chemical operations and processes are available to either reclaim these contaminants for reuse, destroy them or isolate them as residues for disposal.



Field demonstration of physical/chemical treatment technology is used to solve industrial environmental problems

The Division comprises engineers, scientists and technologists with expertise in the areas of precipitation, coagulation, sedimentation, filtration, membrane techniques (such as reverse osmosis, ultra- and micro-filtration, electrodialysis), adsorption, ion exchange, and oxidation processes including chemical and photo-chemical techniques.

There are currently six programs within the Physical/Chemical Processes Division:

- Contaminated Groundwater Treatment Technology
- Mining
- Oil and Gas
- Metal Fabrication and Finishing
- Industrial Pretreatment and Recycling Technologies
- Development of Advanced Physical/Chemical Treatment Technologies.

## Contaminated Groundwater Treatment Technology

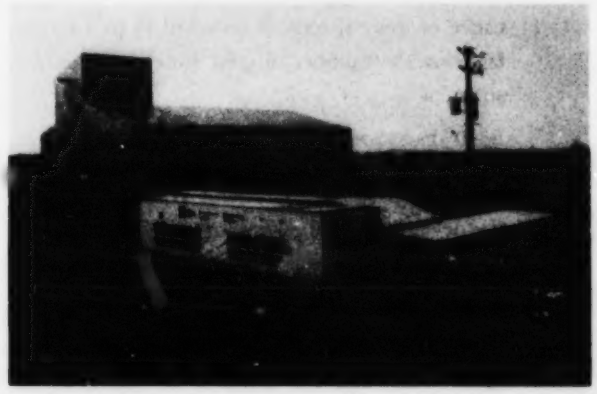
Approximately 26 percent of Canada's population relies on groundwater as a source of drinking water. The contamination of groundwater by hazardous substances can have very serious repercussions and is a major environmental concern. Sources of groundwater contamination include: poor waste management and disposal practices at industrial sites; active and abandoned hazardous waste sites; spills and leaks of hazardous chemicals; and the application of herbicides and pesticides to agricultural land.

The primary objective of this program is to develop and demonstrate cost-efficient technologies for the treatment of contaminated groundwater. The selection of appropriate technology is a func-

tion of the site hydrogeology as well as the type, concentration and extent of contamination. Treatment may include physical/chemical as well as biological processes applied in conjunction with groundwater extraction techniques (pump and treat) or within the aquifer (*in situ*).

## Recent Activities and Accomplishments

- Assisted in a pilot scale experimental program on the use of advanced oxidation processes to treat volatile organic compounds from contaminated groundwater at Transport Canada's Gloucester landfill site. Data from the study will be used in the design of a full scale treatment system for decontamination of the groundwater. Construction is expected to begin in 1991.
- A report on the assessment of the efficiency of the pump and treat remediation technology presently being used to treat a contaminated drinking water supply aquifer near Ville Mercier, Quebec, was prepared. Results indicate that the treatment process is not completely effective in removing the chlorinated and non-chlorinated hydrocarbons and that significant "pockets" of dense non-aqueous phase liquids (DNAPL) remain in the soil and will continue to contaminate the aquifer unless additional remedial measures are undertaken. Pilot scale treatment studies demonstrated that the extracted water could be treated to drinking water standards.
- The national Groundwater and Soil Remediation Program (GASReP) was established to research, develop and demonstrate technologies for the remediation of groundwater and soil contaminated by hydrocarbons. Participants in the program include the federal government and several provincial governments, the Canadian Petroleum Products Institute, the Canadian Petroleum Association, the American Petroleum Institute, and the U.S. Environmental Protection Agency. Research studies in the areas of *in situ* bioremediation, excavation and treatment technologies, *in situ* volatilization technologies and off-gas treatment technologies were prepared. Research in the areas of *in situ* bioremediation of benzene, toluene, ethyl benzene and xylene (BTEX) under anaerobic conditions by denitrifying bacteria, as well as the use of intercedent *in situ* biological barriers and solvent extraction of hydrocarbons from soil using natural gas condensate and iron pretreatment, was also carried out.
- Three conferences were held in support of program initiatives: the First Annual GASReP Symposium; the Advanced Oxidation Processes Symposium; and a Conference on the Prevention and Treatment of Contaminated Groundwater and Soil for the Petroleum Refining and Distribution Industry.
- A major contract to assess groundwater contamination at an organic chemicals plant and to investigate treatment alternatives was completed.
- Bench and pilot scale advanced oxidation process studies were undertaken on dimethylnitrosamine in groundwater.
- Technical advice was provided to the national Development and Demonstration of Site Remedial Technology (DESRT) program.



Example of groundwater treatment operations at Ville Mercier, Quebec

### Future Challenges

- Develop a research and demonstration program to address Dense Non-Aqueous Phase Liquids (DNAPL) contamination in the soil and fractured bedrock.
- Evaluate, develop and field demonstrate new technologies for above ground and *in situ* treatment of contaminants in soil and groundwater.
- Develop treatment technologies for volatile compounds present in the off-gas from groundwater and soil remediation technologies.
- Provide support to the National Groundwater and Soil Remediation Program (GASReP).
- Continue participation on the NATO Committee on Challenges to Modern Society Pilot Study on the Demonstration of Remedial Action Technologies for Contaminated Soil and Groundwater.
- Investigate the application of specific biotechnologies for groundwater treatment. These include *in situ* bioremediation within aquifers, the use of biologically activated carbon for drinking water supplies and the use of biological filters for off-gas treatment.
- Investigate the kinetics of formation and degradation of viny chloride under anaerobic conditions in order to identify possible treatment technologies for the biodegradation of perchloroethylene.

## Mining

The mining and milling of metallic ores generates large quantities of aqueous wastes which can contain high levels of various toxics such as cyanide and heavy metals. These wastes are generally discharged into tailing ponds where solids settle out of solution. The remaining liquid fraction is either recycled or discharged to the environment after appropriate treatment. The significance of this industry is reflected in part by the fact that the number of gold mines has doubled since 1985.

As one of the world's major producers of precious and base metals, Canada is also a leader in the development of technologies to remove contaminants from metal mining wastes. The Physical/Chemical Processes Division has been a key contributor in developing treatment technologies for the gold and base metal mining industries. The primary objective of the mining program is to develop improved and more cost-efficient methods of removing cyanide, heavy metals and other contaminants from effluents.

### Recent Activities and Accomplishments

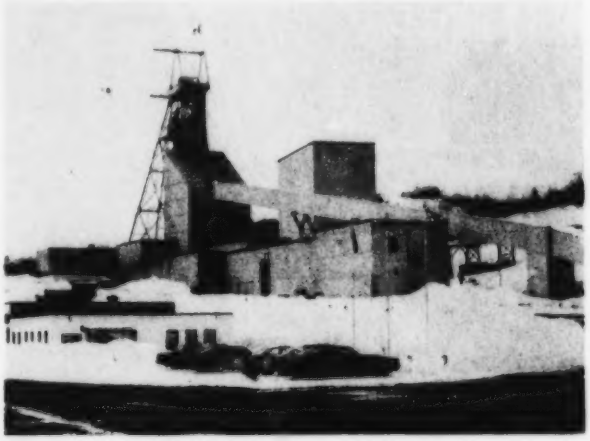
- A preliminary mathematical model for the design of a gold mill effluent treatment system utilizing natural degradation processes was developed.
- A prototype cyanide analysis training video for industry and regulatory personnel was produced and is being marketed.
- A state-of-the-art document on the hydrogen peroxide process for treating gold mill effluents was completed. This essentially completes the work of the WTC in evaluating full scale alternative technologies for the treatment of gold mining wastewaters.
- A project has been initiated to evaluate and demonstrate suitable cyanide/metals recovery and recycle technologies applicable to gold mill effluents to encourage industry to implement waste minimization techniques.
- A multi-year project is underway to develop a knowledge-based expert system for process

evaluation and to design gold mill effluent treatment systems for achieving the Best Available Technology Economically Achievable (BATEA).

- Six knowledge bases were developed for the first prototype of an expert system for selecting the Best Available Technology based process for the treatment of gold mill effluents.
- A review of the best available technologies for the treatment of high salinity effluents from salt mining operations was completed under funding from MISA. A comprehensive report on the subject was submitted to the Ontario Ministry of the Environment.

### Future Challenges

- Identify technology development requirements for physical/chemical treatment of effluents from various mining sectors including uranium, base metals, and gold.
- Identify advanced industrial materials such as specific coagulants, new polymer membranes and supported liquid membranes for use in treating mining effluents.
- Continue the development of innovative alternative technologies to ensure the cost-effective recycling of cyanide in gold metal mines.
- Develop and demonstrate innovative technologies to remove trace levels of metals from mining effluents to achieve the goal of virtual elimination of persistent toxic substances.



On site demonstration of treatment technology is essential in developing effective solutions for the mining industry

- Complete the development of the first prototype expert system for designing gold mill effluent treatment plants, and initiate testing of the system by selected users and experts.

## Oil and Gas

Heavy oil and tar sand deposits in Alberta and Saskatchewan contain nearly 90 percent of Canada's oil reserves. The viscous oil in these deposits cannot be recovered by conventional techniques and must be extracted using special techniques such as steam injection. This method generates a wastewater, generally referred to as "produced water", which is contaminated with oil, suspended solids, total dissolved solids, silica and dissolved organics. Offshore oil production generates a produced water which contains elevated levels of oil and suspended solids.

The overall objective of this program is to ensure the development of these resources in an environmentally sound manner. The specific objective of the heavy oil component of the program is to investigate, develop and demonstrate cost-efficient treatment technologies which would enable produced water to be recycled to once-through

steam generators. The objective of the offshore component of the program is to evaluate state-of-the-art oil removal technologies and to develop a reliable on-line oil-in-water monitor for produced waters. This will lead to better control of the treatment process and enhanced environmental quality.

WTC staff examining a pilot scale microfiltration unit at the Amoco Canada facility in Elk Point, Alberta

## Recent Activities and Accomplishments

- A bench scale field evaluation of the electrodialysis process for removing total dissolved solids from produced water was completed and the information from the test work was used to design a pilot scale experimental program and equipment.
- Medium term pilot scale field tests were conducted on ultra-filtration/micro-filtration (UF/MF) membranes from two suppliers to evaluate their effectiveness in removing oil and suspended solids from produced waters from *in situ* recovery of heavy oil.
- Static hydrocylones were tested on simulated produced water from one Canadian offshore oil field. An experimental program was developed and arrangements made for testing the rotary hydrocyclone on simulated produced water from Canadian offshore oil production.
- A data base on the available commercial oil-in-water monitors was developed, and an experimental program was finalized for the evaluation of the best available monitors.
- Contacts were established with the United States Environmental Protection Agency, the Association for Testing and Materials, the American Petroleum Institute, to collect information on the status of their activities/regulations related to the analysis of produced waters for oil and grease. Experimental work was started to develop a protocol specifically suitable for analyzing produced waters for oil and grease.

## Future Challenges

- Complete field pilot tests to evaluate the cost-effectiveness of the electrodialysis process for the removal of total dissolved solids from produced waters from *in situ* recovery of heavy oil in Western Canada.
- Initiate work on systematic development and testing of UF/MF membranes for the removal of oil and suspended solids from produced waters.
- Complete the testing of a rotary hydrocyclone on simulated Canadian offshore produced water.
- Complete the evaluation of the selected oil-in-water monitors in collaboration with the Canadian Navy.
- Maintain an effective program to support oil and gas industry needs in relation to pollution prevention and innovative pollution control technology development.

## Metal Fabrication and Finishing

Effluents released during metal fabrication and finishing operations such as those from the iron and steel industry, the metal casting industry and plating operations are toxic. Contaminants include toxic metals, polynuclear aromatic hydrocarbons, heterocyclic nitrogenous compounds, cyanide and phenolics. Discharges from these industries are made either directly to surface waters or indirectly via municipal water pollution control plants which are not normally designed or operated to effectively remove these contaminants.

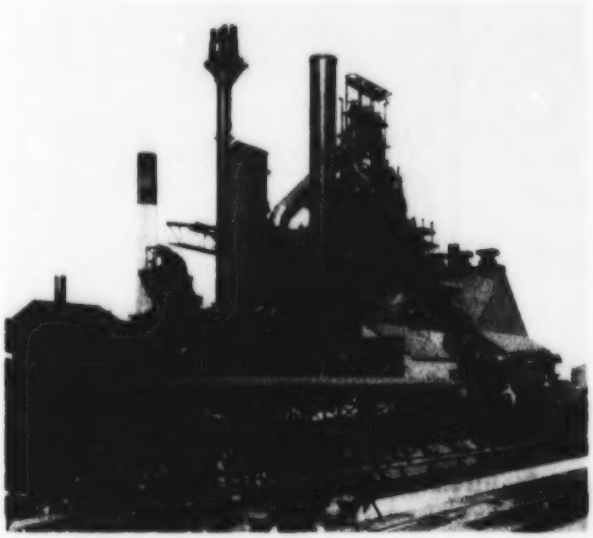
The objective of the metal fabrication and finishing program is to evaluate existing treatment methods, to develop innovative, cost-efficient treatment methods and to develop waste minimization strategies to realize the long-term objective of virtual elimination.

### Recent Activities and Accomplishments

- A study of the feasibility of automated process control for the alkaline chlorination process in a local metal finishing facility was completed. The study demonstrated effective control of the chlorine dosage, which resulted in the effective control of cyanide.
- Technical support and advice continued to be provided to the Ontario Ministry of the Environment's MISA Program for the development of regulations for the iron and steel, and metal casting industries.
- The WTC is conducting a jointly funded study with the Ontario Ministry of the Environment on the development and optimization of filtration technologies for selected iron and steel mill effluents.
- Advice and technical support was provided to the Automotive Parts Manufacturers Association with respect to pollution prevention strategies.

### Future Challenges

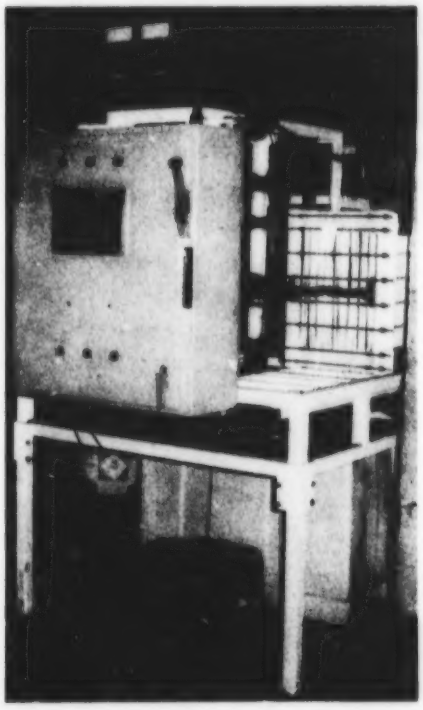
- Conduct an assessment of current treatment technologies in the metal finishing industry and evaluate the potential for metal recovery.
- Develop and demonstrate effective, economically achievable technologies for improved effluent treatment in the metal casting industry.
- Assist the iron and steel industry to develop and implement technologies to achieve virtual waste elimination.
- Identify advanced industrial materials such as specific coagulants and new polymer membranes applicable for use in treating effluents from the metal finishing and fabrication industry.



**Innovative and cost-efficient treatment is developed in conjunction with industry** (Photo courtesy of Dofasco Visual Services)

# Industrial Pretreatment and Recycling Technologies

A major focus in the treatment of wastewaters is the pretreatment of specific wastes at the source before they are discharged to municipal sewers or to the environment. Numerous industries such as metal finishing plants, paint and pigment manufacturers, chemical plants and commercial operations such as dry-cleaning establishments discharge their effluents to municipal sewers. Many of these wastes can be treated effectively while they are in a relatively pure and concentrated form and reuse of the recovered material is often possible. The contaminants in these wastes can be very difficult to remove or destroy after dilution and mixing within municipal sewers. Also, they can adversely affect the operation of municipal sewage treatment processes.



Pre-treatment of metal finishing wastewaters

The objective of this program is to identify and develop new technologies, including advanced industrial materials, for recovering specific contaminants from industrial effluents. Recycling and recovery technologies are emphasized in this new program area.

## Recent Activities and Accomplishments

- A major project has been initiated to evaluate and develop membrane technologies for specific industrial wastewaters. These technologies include electrodialysis, ultra-filtration, micro-filtration, pervaporation, new polymer membranes and supported liquid membranes.

## Future Challenges

- Develop an expert system to evaluate alternative process schemes for effluent treatment to provide more cost effective designs.
- Evaluate treatment technologies for wastes containing chlorinated hydrocarbons.
- Investigate the use of tailored ultra- and nano-filtration membranes for removing toxic organics from selected process effluents at pulp and paper mills.
- Collaborate with selected industries to fully implement and demonstrate recovery/recycle technologies for virtual elimination of contaminant discharges.

# Development of Advanced Physical/Chemical Treatment Technologies

The general objective of this program is to improve efficiency and reduce the operating costs of municipal and industrial wastewater treatment processes by optimizing their design and operational parameters. The program is divided into three tasks: 1) improvement in process knowledge; 2) the comprehensive design of process vessels; and 3) automated process monitoring and control. The current focus is on small particle research, precipitation, coagulation, flocculation, and granular media filtration.

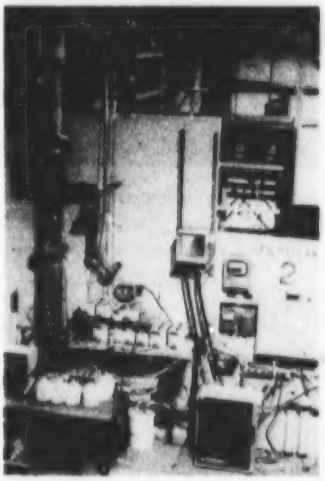
Small particle research involves characterization of suspended particles, including knowledge of their size, shape, density, and surface properties. Existing methods of measuring particles, such as by the turbidity of the effluent, are insufficient to achieve higher quality effluents.

The precipitation of soluble pollutants such as phosphorus and the aggregation of precipitate particles and other suspended material by coagulation and flocculation are common to many wastewater treatment processes. The efficiency of such processes depends on many physical and chemical conditions in the system, which typical experimental designs fail to simulate adequately. Process improvements can be achieved through comprehensive experimental procedures.

Granular media filtration is used in wastewater treatment, drinking water treatment and within industrial processes. Although widely used, the mechanisms responsible for particle removal by filters are complex and not fully understood. Hence, filter design has generally been based on trial and error methods which are time consuming and can create an inefficient product. Improved design and operating procedures will provide cost savings and better effluent quality.

## Recent Activities and Accomplishments

- The cooperative program with McMaster University is continuing to develop the expertise and analytical capabilities required to form a small-particle technology basis for process development projects. This program has contributed to filtration and flocculation studies and has provided small-particle characterization data to other projects.



Pilot scale technology demonstrates filtration optimization and process control

- A study of tertiary filtration at full scale was initiated at the Dundas Wastewater Treatment Plant with the goal of optimizing the process and implementing on-line, automated process control for the removal of various contaminants, including suspended solids and phosphorus.
- A study was initiated of coagulant addition to the activated sludge process with the objectives of understanding the interactions

between the precipitate and the biomass, and minimizing the discharge of phosphorus and suspended solids.

- A filtration model describing the behaviour of suspended particles in a granular filter bed has been developed. The model is being used to explore the mechanisms of filtration and to predict the performance of filters. Modelling results have indicated that particle agglomeration is a dominant mechanism.
- Work is continuing toward the development of a numerical simulator model for flocculation operations. New laboratory techniques are being developed for flocculation measurement.

## Future Challenges

- Develop analytical capabilities and expertise in the area of small particle analysis in order to better understand process performance.
- Utilize a combination of mathematical simulation, expert systems, and automated bench scale and pilot scale equipment to develop new approaches to the development of physical/chemical process technologies.
- Develop a flocculation simulation program and a filtration simulation program.

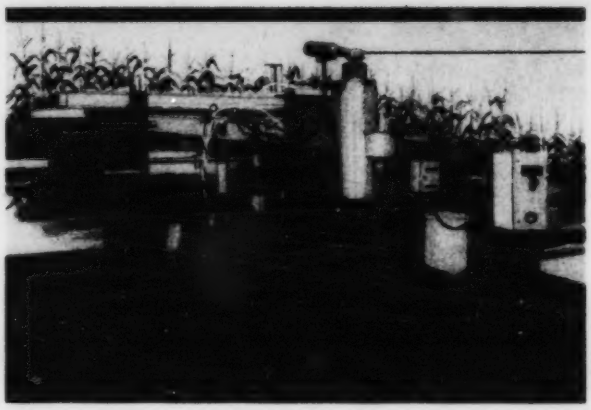
# Residue Management Division

Research and technology development activities within the Residue Management Division support the management of sludges and other wastes, the treatment of contaminated soils and the remediation of decommissioned industrial sites.

Programs dealing with sludge and residue management involve the development of technologies and methods for their volume reduction, safe disposal and practical utilization. Remediation activities involve the development of strategies for the clean-up of decommissioned industrial sites, particularly the *in situ* treatment of contaminated soils.

Programs currently being undertaken by the Residue Management Division include:

- Sludge Treatment
- Land Application of Sludge
- Waste Characterization
- Waste Solidification and Stabilization
- Site Remediation



Pilot scale research assists in determining better methods of sludge management

## Sludge Treatment

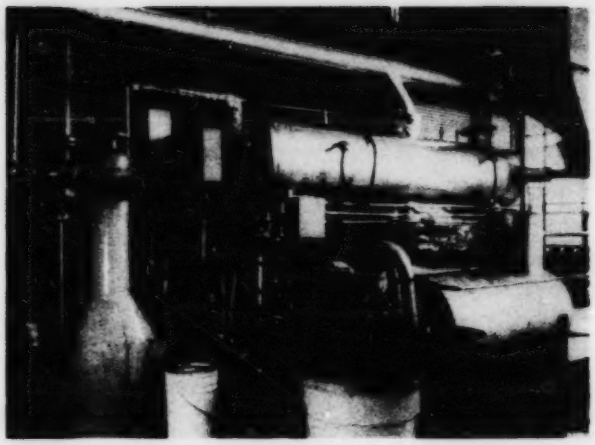
The treatment of municipal wastewaters results in the production of large volumes of sludge. The management of this material, particularly in terms of dewatering and disposal, is costly and a potential environmental concern. Methods which enhance the management of sludge, such as improving the efficiency of dewatering and reducing the volume of material, will provide substantial benefits. Additional benefits are derived from conversion techniques that generate marketable products such as fuel oil.

Two technologies developed by the Residue Management Division form the basis for the current sludge treatment program. These technologies are the Sludge Conditioning Controller and the Oil-From-Sludge process.

The Sludge Conditioning Controller effectively measures and adjusts the amount of polymer added to the wastewater stream to enhance the dewatering process. The controller has demonstrated significant cost savings by reducing polymer consumption.

The Oil-From-Sludge process is a tremendous technological achievement as it reduces the volume of sludge, saving disposal costs, while producing an economic commodity. The low temperature conversion of sludge to fuel oil results in operational savings of between $40 and $60 per tonne of sludge.

The objectives of the WTC Sludge Treatment Program are to refine these technologies, to



Oil-from-Sludge pilot plant used to evaluate low temperature conversion of sludge to liquid fuel

demonstrate them at operational scale, to assess sludge-derived oil upgrading techniques and to assess environmental implications of combustion of the synthetic fuel oil.

### Recent Activities and Accomplishments

- A demonstration of the Sludge Conditioning Controller at a municipal sewage treatment plant indicated a 24 percent reduction in polymer consumption. Subsequent marketing by Zenon Environmental Limited resulted in sales or trial installations in ten different countries.
- Canadian Patents and Development Limited have licensed the Oil-From-Sludge technology to Enersludge, a Canadian company. Patents have been issued in the United States and Canada and are pending in several other countries.
- A 45 tonne/day facility to demonstrate the Oil-from-Sludge technology at full scale in Toronto, Ontario is being designed.
- A report summarizing the state-of-the-art of instrumentation in sludge processing systems in Canada and the United States has been completed.

### Future Challenges

- Transfer information on the Oil-From-Sludge technology to municipalities and demonstrate the system at full scale in Canada.
- Promote the further application of the Sludge Conditioning Controller by providing technical information to end-users.
- Provide technical, financial and marketing support for further demonstration, testing and commercialization of other sludge treatment technologies, including the rotary press.
- Develop a methodology for conducting process audits of sludge processing systems.
- Complete design and initiate construction of Highland Creek Oil-from-Sludge plant and conduct an environmental review of the process.

## Land Application of Sludge

The application of municipal sludge to agricultural land is a cost-efficient method of sludge utilization which allows the recycling of valuable plant nutrients. Approximately one-third of municipal sludge produced in Canada is utilized in this manner. The presence of toxic constituents in municipal sludge requires that guidelines be developed to minimize hazards associated with land application.

Land application may also have potential for the treatment and disposal of heavy oil wastes and

industrial sludges. However, current information on the nature and fate of the contaminants in these sludges, when applied to soil, is inadequate for the development of codes of practice or regulations.

The objectives of the land application of sludge program are to develop and demonstrate technology that permits the land application of municipal sludge in a sound environmental manner, to determine the fate of toxic chemicals in heavy oil wastes and industrial sludges when applied to soil, to determine the treatability of heavy oil waste and industrial sludges, to develop techniques for heavy oil waste treatment, and to assist in the development of guidelines and regulations for land application.

### Recent Activities and Accomplishments

- A methodology was developed to measure volatile organic contaminants in sludge/soil/water matrices. This approach can be used to determine the fate of these contaminants in sludge applied to agricultural land.
- A microcosm technique for studying plant uptake of organic contaminants from sludge-amended soils was developed. The results from microcosm studies will be instrumental in determining the need for regulations relating to organic contaminants in sludges applied to land.
- Biometer flask, microcosm and incubation flask experiments on the fate of toxic organics in oily wastes applied to land have been completed. Degradation rates and half-lives for ten target compounds have been established.

### Future Challenges

- Expand the scope of laboratory, greenhouse and field studies to develop a database for establishing guidelines/regulations for the application of sludge containing organic chemicals to agricultural land.
- Generate information for use in the development of guidelines for the land application of heavy oil and other industrial wastes.
- Survey Canadian sludges for organic contaminants, heavy metals and surfactants.
- Continue microcosm studies.

In house studies develop a data base for land utilization of sludge

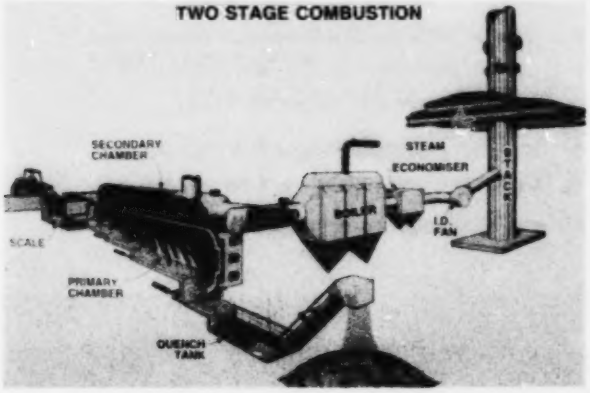
## Waste Characterization

Waste disposal sites have been identified as major contributors of toxics to the ecosystem. Knowledge of the nature and leachability of toxics within different wastes is very important in developing strategies and technologies for proper waste disposal.

The incineration of municipal solid waste and industrial hazardous wastes is one strategy that has been employed to reduce the volume of waste requiring landfilling. The residues (ashes) from incinerators have received only preliminary characterization with regard to their suitability

for landfilling. Improved characterization is necessary to develop regulatory requirements for these residues.

The objectives of the waste characterization program are to identify the toxic constituents of various waste residues, to investigate their leachability, to assess methods for conducting leaching tests and to provide advice on the proper disposal of various waste residues. Expert systems will be used in conducting these waste characterization assessments.




**Schematic of a municipal solid waste incinerator**

## Recent Activities and Accomplishments

- The physical, chemical and leaching characteristics of bottom and fly ashes from nine municipal solid waste incinerators were evaluated. Solidification and stabilization techniques for immobilizing inorganics in the fly ashes were examined. The results were incorporated into "Operating and Emission Guidelines for Municipal Solid Waste Incinerators" published by the Canadian Council of Ministers of the Environment.
- The LANDIS (LANd DISposal) expert system is being developed under contract to the WTC. The main component of LANDIS is a data interpretation and decision-rendering expert system which also coordinates information flow between itself and several specialized modules including a database containing the results of waste analyses and various leaching tests, and the HELP (Hydrological Evaluation of Landfill Performance) model developed by the USAE Waterways Experiment Station. LANDIS will allow users to identify appropriate leaching tests for wastes, to evaluate the suitability of wastes for landfill disposal, and to examine alternative waste processing options for wastes failing the disposal criteria.

## Future Challenges

- Enhance and expand the applicability of the LANDIS waste characterization system by accumulating additional data and knowledge from experts and demonstrate the technical viability of the system.
- Initiate field studies on the disposal of municipal solid waste ashes based on data developed under the National Incinerator Testing and Evaluation Program in order to identify the acceptability of various disposal scenarios.
- Investigate the potential for developing advanced industrial materials for use in landfill site liners.

## Waste Solidification and Stabilization

Landfilling is the disposal method for the many hazardous wastes that cannot be recycled or reused for practical or economic reasons. Leaching of toxic contaminants from these wastes into soil and surface waters presents a very serious environmental problem. Solidification and stabilization techniques improve the physical and chemical characteristics of the wastes such that leaching and off-site transport of toxic contaminants is minimized or eliminated. These techniques need to be evaluated using standardized protocols to allow regulatory agencies to develop appropriate guidelines for environmental protection.

The objectives of the Waste Solidification and Stabilization Program are to develop, validate, and standardize test methods for characterizing the effectiveness of solidification techniques, to promote the utilization of the tests developed, to promote the use of demonstrated solidification and stabilization techniques for the safe disposal of hazardous wastes, and to develop predictive models for assessing the potential for leaching of solidified wastes under field conditions.

Extensive studies demonstrate the effectiveness of waste solidification/stabilization technologies

### Recent Activities and Accomplishments

- A study conducted by the WTC, in conjunction with a number of other governments and solidification vendors, evaluated 16 laboratory test methods for characterizing solidified wastes. The study determined the variability of each test method and the variability among wastes solidified by different vendors. A significant database on solidified waste characteristics was developed.
- A report based on data generated in the above study ("A Proposed Evaluation Protocol for Stabilized/Solidified Wastes") will provide a basis for establishing solidified waste performance criteria which can be used to evaluate various disposal scenarios.
- Another report entitled "A Compendium of Waste Leaching Tests", was completed which addresses the generic problem of waste leaching and provides an overview of various types of leaching tests and their interpretation.
- The applicability of existing solidification processes to a number of wastes were evaluated for the Ontario Waste Management Corporation. This information will be used in the development of the Corporation's hazardous waste disposal facility.

### Future Challenges

- Develop and promote a rational approach to evaluating the long-term environmental impacts of disposing of solidified and stabilized hazardous wastes.

- Establish a program to evaluate the utilization of waste materials (including solidified wastes) as an alternative to disposal.
- Establish a coordinated research program with other institutes undertaking work in this area.

## Site Remediation

Substantial quantities of soil contaminated with chlorinated organic compounds such as polychlorinated biphenyls and pentachlorophenol are awaiting a suitable method for clean-up and disposal. Given the volume of soil involved, the potential for spillage during transportation to incinerator facilities and the high cost of incineration, alternative treatment methods need to be developed. *In situ* biodegradation using microbial organisms offers the potential for a safe, cost-efficient solution.

Pressure for land development is in most urbanized portions of Canada. In these areas, decommissioned industrial sites are in demand for redevelopment. Many of these sites have contaminated soils which must be assessed and treated prior to reuse. The Residue Management Division has managed a joint government/industry program to develop an expert system that determines clean-up criteria for industrial site remediation. The Aid for Evaluating the Redevelopment of Industrial Sites (AERIS) expert system calculates the concentrations of a pollutant in soil, water air and plants, and predicts the potential human exposure to the pollutant in anticipated land use scenarios.

**Typical industrial site requiring remediation (Sydney Tar Ponds)**

The objectives of the Site Remediation Program are to develop *in situ* biodegradation techniques for the decontamination of soils containing chlorinated organic compounds and to demonstrate and expand the usefulness of the AERIS program to industry and regulatory agencies.

### Recent Activities and Accomplishments

- The AERIS expert system was demonstrated to several government agencies and industrial associations.
- A license to commercialize the AERIS expert system was granted to a Senes Consultants Ltd./Monenco Consultants Ltd. joint venture.
- *In situ* bioremediation treatment techniques for soils contaminated with pentachlorophenol were developed.

## Future Challenges

- Promote the acceptability of risk assessment approaches, such as the AERIS expert system, to define clean-up criteria for site remediation.
- Develop an expert system in support of regulatory requirements for the remediation of contaminated sites.
- Undertake research and provide technical advice to the federal abandoned-site remediation program.
- Field demonstration of enhanced biodegradation of hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), pentalchlorophenols (PCPs) and other chlorinated phenolics *in situ* and of excavated material.
- Participation in a joint bioreactor research and demonstration study for hydrocarbon contaminated soil.
- Demonstration of technologies to remediate contaminated sediments from the Great Lakes.
- Participate in Assessment and Remediation of Contaminated Sediments (ARCs) meetings.
- Develop and demonstrate technologies to remediate soils contaminated with chlorophenoxy herbicides, volatile organics, dioxins and other organic and inorganic compounds.
- Conduct an *in situ* bioremediation symposium, jointly with the National Water Research Institute, International Association of Hydrological Sciences (IAHS), the University of Waterloo and Rice University.
- Provide technical advice and support to the Development and Demonstration of Site Remediation Technology program.
- Develop a handbook on contaminated site assessment.

# Laboratory Division

The complexity and variety of wastes generated by Canada's industries and municipalities demand extensive analytical capabilities to provide data for environmental research and technology development agencies. Many wastes contain a complicated mix of contaminants at varying concentrations. The nature of the material being analyzed often presents a challenge to instrumentation designed for less complicated matrices. In addition, exacting quality control and quality assurance standards are required to provide data for regulatory development, assessment and monitoring.

The Laboratory Division of the WTC has been very successful in meeting these requirements. Analytical support is provided to the three research and engineering divisions. Chemical analyses for conventional pollutants, toxic organics and toxic metals are conducted using gas chromatographs, mass spectrometers, atomic absorption, and plasma emission spectrometers, scintillation counters and automated analyzers. The Laboratory Division also provides advice on sampling protocols, data interpretation and quality assurance, and conducts research on analytical methods and enhanced sampling techniques.

Research on analytical methods, advice on sampling protocols, and data interpretation are essential services provided by the Lab Division

Analytical support and advice is provided to other components of Environment Canada, and to various other federal agencies and provincial regulatory services. The Laboratory also analyzes legal samples in support of the Canadian Environmental Protection Act. All work conducted by the Laboratory Division is on a cost-recovery basis.

## Recent Activities and Accomplishments

- Sludge and vegetation material were analyzed for polychlorinated biphenyls (PCBs) and pesticides to determine the fate of these compounds in land application.
- An investigation was conducted to determine possible UV-photolysis degradation products from irradiation of N-nitrosodimethylamine (NDMA) in aqueous solution.
- An analytical method was developed for the determination of chlorofluorocarbons (CFCs) in aerosol products, which will lead to a routine method for monitoring these products.
- Microwave technology was developed for the preparation of environmental samples involving metal analysis.
- The Laboratory Division provided emergency response for the tailing spill at Matechewan.
- A methodology was developed for the analysis of total mercury in environmental samples.
- Participation in a program to remove NDMA in Elmira drinking water resulted in the implementation of an analytical method involving the use of isotope dilution to determine the presence of NDMA.

- As part of a project carried out for the Ontario Ministry of the Environment and the Canadian Association of Environmental Analytical Laboratories (CAEAL), the WTC developed a series of stable reference materials which contained several sewage effluent parameters. These standards were then used in a 90-laboratory round robin study to assess the quality of results generated by commercial and sewage treatment plant laboratories across Ontario.

## Future Challenges

- Improve the accuracy of analysis for priority pollutants in sewage sludge by the wider use of isotope dilution techniques.
- Broaden the use of canister and sorbant trapping techniques for the analysis of volatile and semi-volatile organics.
- Implement a sample tracking and quality assurance program using a local area computer network and a database program.
- Establish a mobile laboratory to support WTC field investigations.
- Investigate and develop the use of on-line phosphorus analyzers.
- Review existing quality assurance/quality control (QA/QC) programs and develop a quality management plan to be used as standard for the WTC's laboratories.
- Maintain the WTC Laboratory capability.
- Participate in and provide industrial effluent QC materials for the Conservation and Protection Laboratory Managers Committee.
- Improve our understanding of environmental chemistry by conducting research into environmental chemical mechanisms and measurements.
- Design and prepare samples for use in interlaboratory analytical studies.

# Computing and Informatics Division

Computer professionals provide real-time programming and expertise in data management

Research, technology development and transfer, analytical and administrative support all have a common requirement — an innovative, high capacity, state-of-the-art computing and information processing capability. The nature and amount of data generated within the WTC and from outside, along with new applications of computing in the fields of artificial intelligence and real-time process control, place tremendous demands on the Computing and Informatics Division. The WTC depends on this Division to support a host of applications involving 110 microcomputers and three HP1000 mini-computers.

Computer support to the WTC can be categorized into two main areas: day to day troubleshooting of hardware and software problems, and the more substantial requirements of project specific activities involving custom programming. In addition, technology development in the wastewater field provides opportunities for innovative computer applications which may involve the development of marketable programs and systems.

## Recent Activities and Accomplishments

- Assistance provided by the Computing and Informatics Division was instrumental in developing microcomputer-based real-time process control systems. These have been used for data acquisition and control in several projects, including an anaerobic pilot plant, automated temperature control at a greenhouse and at pilot scale treatment plants at Ville Mercier, Quebec, and the Dofasco Inc. steel manufacturing facility in Hamilton.
- Two microcomputer-based dynamic modelling systems were developed. One program predicts the fate of various toxic chemicals as they flow through the aerobic treatment process. The second was created to monitor the natural degradation of cyanide during treatment. Both systems are equipped with a third-party graphics package for producing plots and charts from operational information.
- Software was developed for an unattended real-time process control system operating at the sewage treatment plant in Tillsonburg, Ontario.
- Data collected by industries as part of the Ontario Ministry of the Environment's MISA program was analyzed using database and statistical procedures on a HP1000 minicomputer. Reports were generated for both the Ontario Petroleum Industry and the Ontario Forestry Industries associations.

## Future Challenges

- Provide computing expertise, hardware support and documentation for the development and operation of expert systems.
- Expand the Division's capabilities with regard to providing desk-top publishing services.
- Introduce an intercomputer communications network (LAN) throughout the WTC allowing multi-user access to data and electronic mail capabilities.
- Upgrade capabilities in support of automated process control systems by acquiring commercial grade front-end packages such as the "FIX" system.

# Support Services Division

The Support Services Division assists and enhances the day-to-day operation of the WTC and its various programs. Responsibilities range from financial and administrative to the design and operation of bench and pilot scale technologies. Activities in the Support Services Division are divided among five sections:

Technology transfer and financial management are essential services provided by the Support Services Division

### Financial Management Services

- provides financial planning, control and tracking

### Materiel Management and Procurement Services

- purchases equipment, supplies and services, and manages the WTC inventory

### Administrative Services

- undertakes the administration of records, accommodation and human resources

### Technology Transfer Services

- facilitates information exchanges and assists in the marketing of WTC technologies and expertise

### Engineering Support Services

- maintains and operates the building and undertakes the design, fabrication and construction of pilot scale facilities and instrumentation and control systems

# Wastewater Technology Centre Contacts

## Management

Bruce Jank
John Neate

## Program Areas for 1991

| | |
|---|---|
| Computer Control of Biological Treatment Processes | Gordon Speirs |
| Trace Contaminant Control | Henryk Melcer |
| Pulp and Paper Wastewater Treatment | Eric Hall |
| Compliance Monitoring Methodology | David Chapman |
| Development of Advanced Biotreatment Technologies | Henryk Melcer |
| Contaminated Groundwater Treatment Technology | Rob Booth |
| Mining | James Schmidt |
| Oil and Gas | Abbas Zaidi |
| Metal Fabrication and Finishing | Derek Vachon |
| Industrial Pretreatment and Recycling Technologies | Abbas Zaidi |
| Advanced Physical/Chemical Treatment Technologies | Dave Averill |
| Sludge Treatment | Herb Campbell |
| Land Application of Sludge | Mel Webber |
| Waste Characterization | Tom Constable |
| Waste Containment | Julia Stegemann |
| Site Remediation | Rob Booth |
| Laboratory Services | Peter Fowlie |
| Computing and Informatics | Brian Monaghan |
| Support Services | Carole Leacock |
| • Financial Services | Deborah Cruz |
| • Procurement and Materiel Management | Judy Czajkowski |
| • Technical Services | Eric Luxon |

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